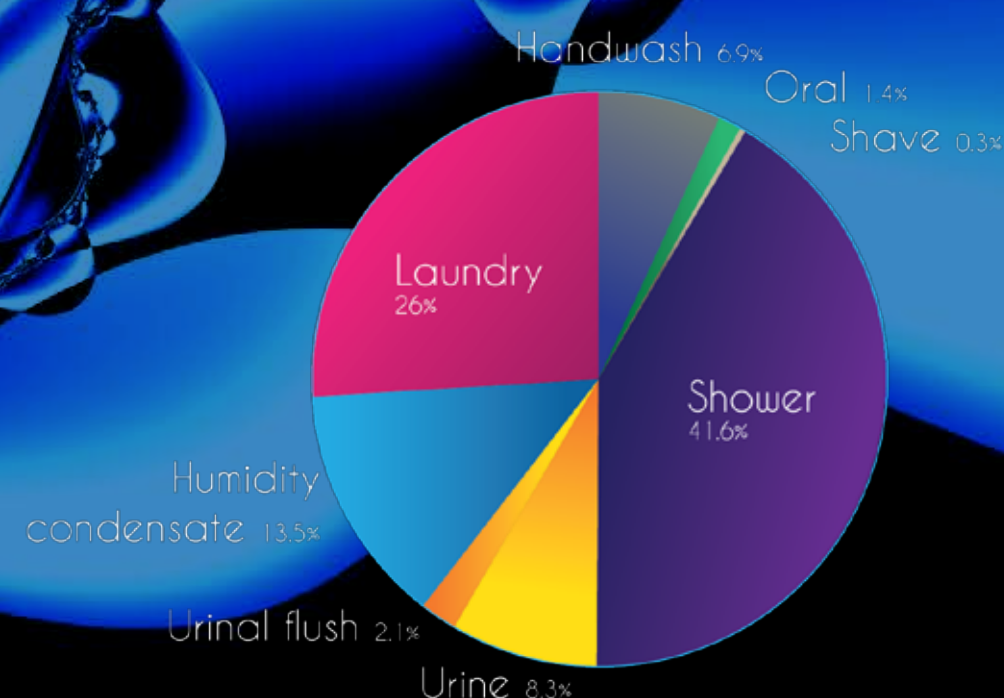
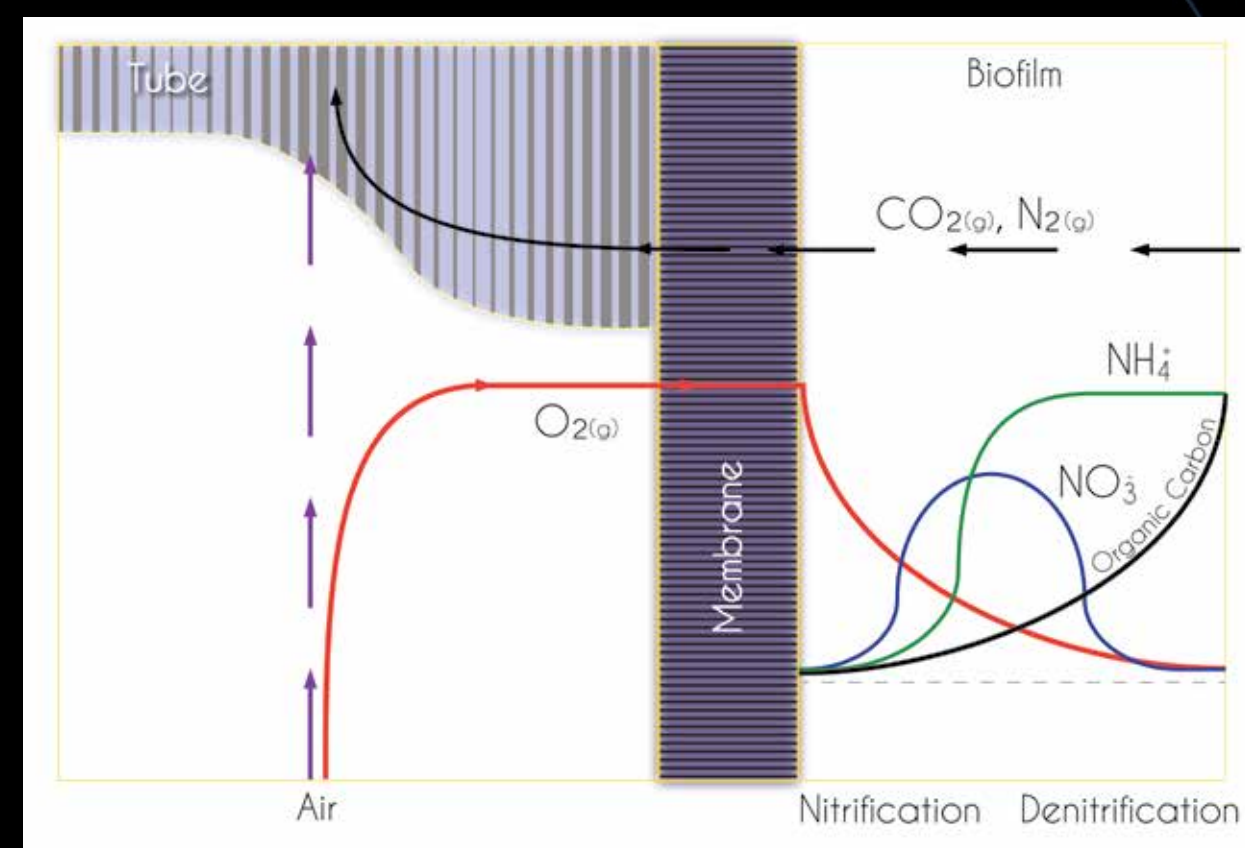


BIOLOGICAL WATER PROCESSOR

Advanced Exploration Systems Life Support Systems



The goal of the Biological Water Processor (BWP) is to remove 90% organic carbon and 75% ammonium from an exploration-based wastewater stream for four crew members. The innovative design saves on space, power and consumables as compared to the ISS Urine Processor Assembly (UPA) by utilizing microbes in a biofilm.

The attached-growth system utilizes simultaneous nitrification and denitrification to mineralize organic carbon and ammonium to carbon dioxide and nitrogen gas, which can be scrubbed in a cabin air revitalization system. The BWP uses a four-crew wastewater comprised of urine and humidity condensate, as on the ISS, but also includes hygiene (shower, shave, hand washing and oral hygiene) and laundry. The BWP team donates 58L per day of this wastewater processed in Building 7.

INNOVATION PERSPECTIVE

The BWP does not require toxic pretreatment to stabilize wastewater. It is a low power, non-thermal, regenerative technology. Additionally, this system is expected to accommodate other wastewater producers, like carbon-rich leachate from solid human or food waste.

INFUSION POTENTIAL

This technology may be on any crew-occupied vehicles including ISS, Orion, and future deep space vehicles and/or planetary bases to recycle wastewater. With post-processing, this system can achieve ~90% water recovery.

PARTNERSHIPS/HIGHLIGHTS

The BWP team is working closely with Texas Tech University to test and refine bioreactor technology. In 2015, TTU will develop a high-fidelity flight design to be tested at JSC. TTU's investment in this technology has been on-going for 13 years.

SIGNIFICANT ACTIVITIES

Completed 570 test days processing 4 crew volume of human-generated wastewater.

Since April 2013, completed three long-duration tests to determine optimum volumetric loading and start-up methods for the BWP.

Achieved 84% carbon removal and 67% ammonium removal from human-generated wastewater.

Reduced system start-up time from 67 days to 13 days, demonstrating that the BWP is viable alternative to a physiochemical process.

Demonstrate that chemical stabilization (i.e. toxic pretreatment) is not necessary for wastewater recycling.

PROJECT MANAGEMENT

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SIGNIFICANT ACTIVITIES

Integrated the FOST to receive wastewater effluent from the BWP.

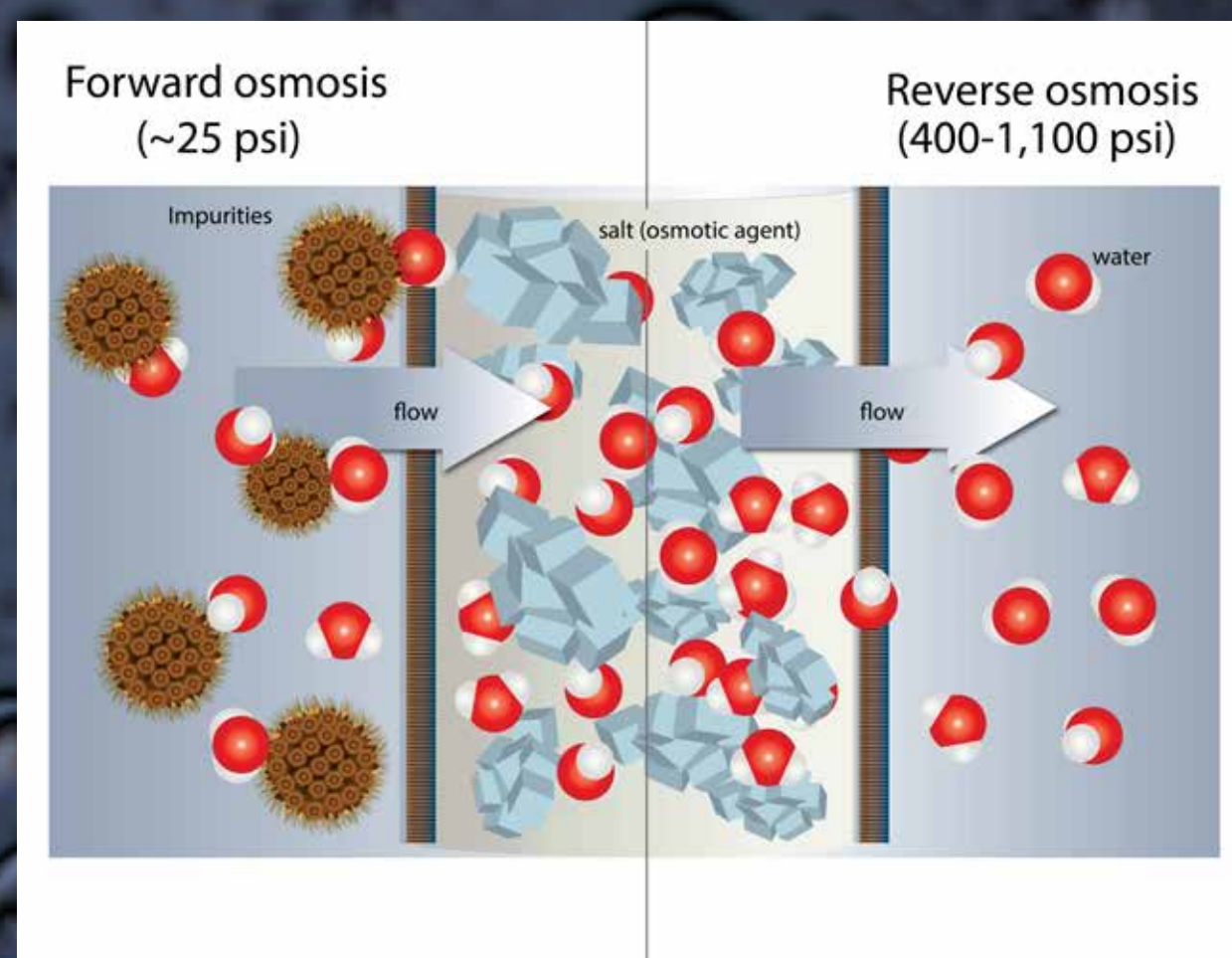
Completed >30 FOST test runs processing human-generated BWP effluent.

Achieved 90% water recovery from wastewater.

Achieved 29% consumables reduction from state-of-the-art ISS UPA.

FORWARD OSMOSIS SECONDARY TREATMENT

Advanced Exploration Systems Life Support Systems



The goal of the Forward Osmosis Secondary Treatment (FOST) subsystem is to recover 90% water from an exploration-based wastewater stream for four crew members. Additionally, the FOST is expected to reduce consumables from the ISS state-of-the-art water recycling system by 20%. The FOST couples forward and reverse osmosis membranes using a draw solution of ~30 g/L NaCl. Large organics from the BWP are rejected on the forward osmosis (FO) membrane. Ionic species and water are drawn in to the salt solution, then concentrated as water is forced through the reverse osmosis (RO) membrane.

Even when using small amounts of acid and anti-scalant to improve salt rejection, the FOST has demonstrated $90 \pm 8\%$ water recovery and $63 \pm 11\%$ consumables reduction as compared to the ISS Urine Processor Assembly (UPA).

INNOVATION PERSPECTIVE

The forward osmosis membrane is used as a first-stage filtration to extend the life of the reverse osmosis membrane by preventing biological fouling and inorganic scaling. Coupling these two membranes of unequal water flux rates is a current challenge to developing a lower-consumable, longer-life water recovery system that aims for >90% water recovery as required by the TA06 Roadmap.

INFUSION POTENTIAL

This technology may be used on any crew-occupied vehicles including ISS, Orion, and future deep space vehicles and/or planetary bases to recycle wastewater. With post-processing, this system can achieve ~90% water recovery.

PARTNERSHIPS/HIGHLIGHTS

The FOST was provided by Ames Research Center (ARC) as part of a larger integrated system, as a secondary treatment to follow the BWP. ARC is working closely with the US Army to develop similar high-yield, low consumable water recovery systems.

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